Terahertz Wave Wireless Communication Pioneered by Organic Electro-optic Polymers

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Biography

1981 Born in Kyoto prefecture.
2009 Completed graduate school's doctoral course (latter period) in Materials Engineering Science, Engineering Science, Osaka University.
2009 After serving as specially appointed assistant professor for Global COE (Core Research and Engineering of Advanced Materials-Interdisciplinary Education Center for Materials Science) in Engineering Science, joined NICT.
2015 Current position.

Research Activities

He is jointly conducting Research and Development for Expansion of Radio Wave Resources, which newly started in FY2021.

Q&As

Q What are you currently interested in outside of your research?

A I play Japanese traditional music ("honkyoku") with a five-holed bamboo Japanese flute ("shakuhachi"). My teacher encourages me to play in a certain style that is not written in the music scores, and I greatly enjoy it.

Q What advice would you like to pass on to people aspiring to be researchers?

A It is important to take an interest in a wide variety of research fields and to broaden your horizons. You should also try to challenge yourself by opening up untapped areas beyond existing research fields.

Q How do you spend your time on holidays?

A I enjoy taking my baby daughter, who was born in March, around the neighborhood. It is an immense pleasure to watch her growing each day.

In order to attain ultra-high-speed, large-capacity wireless communication in Beyond 5G, radio-over-fiber (RoF) technology is attracting attention. This transmits signal waveforms of terahertz waves (0.1–10 THz), which have higher frequencies than radio waves, as optical signals by using optical fibers. A RoF signal converter converts between optical and radio signals at each remote antenna. As terahertz waves have higher directionality than radio waves, the range covered by one remote antenna is limited and so a huge number of remote antennas are required. For this reason, high-performance, small, low-cost remote antenna transceivers need to be developed.

Existing remote antenna receivers using electronic technologies convert from terahertz to electrical signals, and then from electrical to optical signals by using an optical modulator. However, those receivers have problems such as complicated mechanisms, large device size, and high cost. We are focusing on organic electro-optic (EO) polymers that enable highly efficient optical modulation at ultra-high speeds above several hundred gigahertz. Our research aims to develop a radio-to-optical signal conversion device that can directly convert from terahertz to optical signals, without conversion to electrical signals.

To create such a device, we have developed our own technology for transferring EO polymer films on which poling (a process for aligning the directions of EO molecules) has been conducted in advance, and have used it to fabricate a device that combines EO polymers with terahertz wave low absorption loss materials, which would be difficult to fabricate by any existing method. With the fabricated device, we have succeeded in observing direct optical modulation by irradiating electromagnetic waves in the 100 GHz band.

We will continue improving the structure of the device in order to increase the radio frequency and optical modulation efficiency, and then work on its practical application.

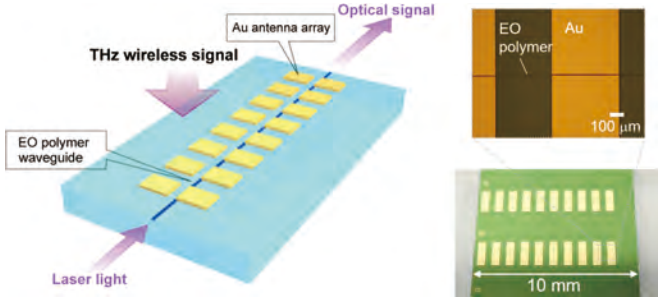

Figure Schematic diagram of radio-to-optical signal conversion device using EO polymer waveguides and Au antenna arrays, and a prototype 100 GHz-band device